Laptop 2.0

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Recap: LinuxTag 2007

 vs.  vs. 

- The suspend challenge openSUSE, Mac OS X and Windows Vista
- Hardware: Apple MacBook, Intel Core 2 Duo (1,83 GHz), 2 GByte RAM
- openSUSE lost all disciplines

The Challenge

- Suspend to disk right after booting the system
- Suspend to disk with many applications running
  - Firefox
  - Thunderbird
  - GIMP
  - OpenOffice Writer
  - RealPlayer

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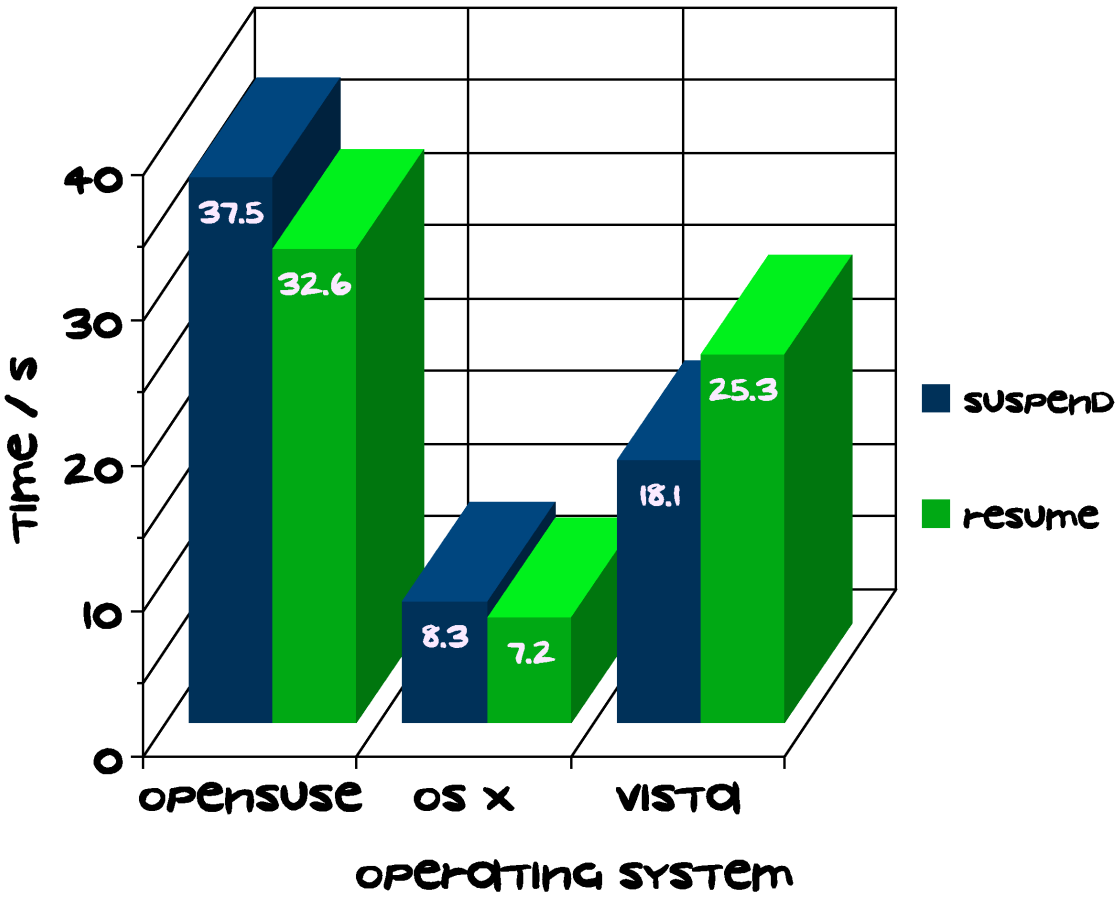
Suspend to Disk (Fresh Boot) – Plain Numbers

Last year (LinuxTag 2007)



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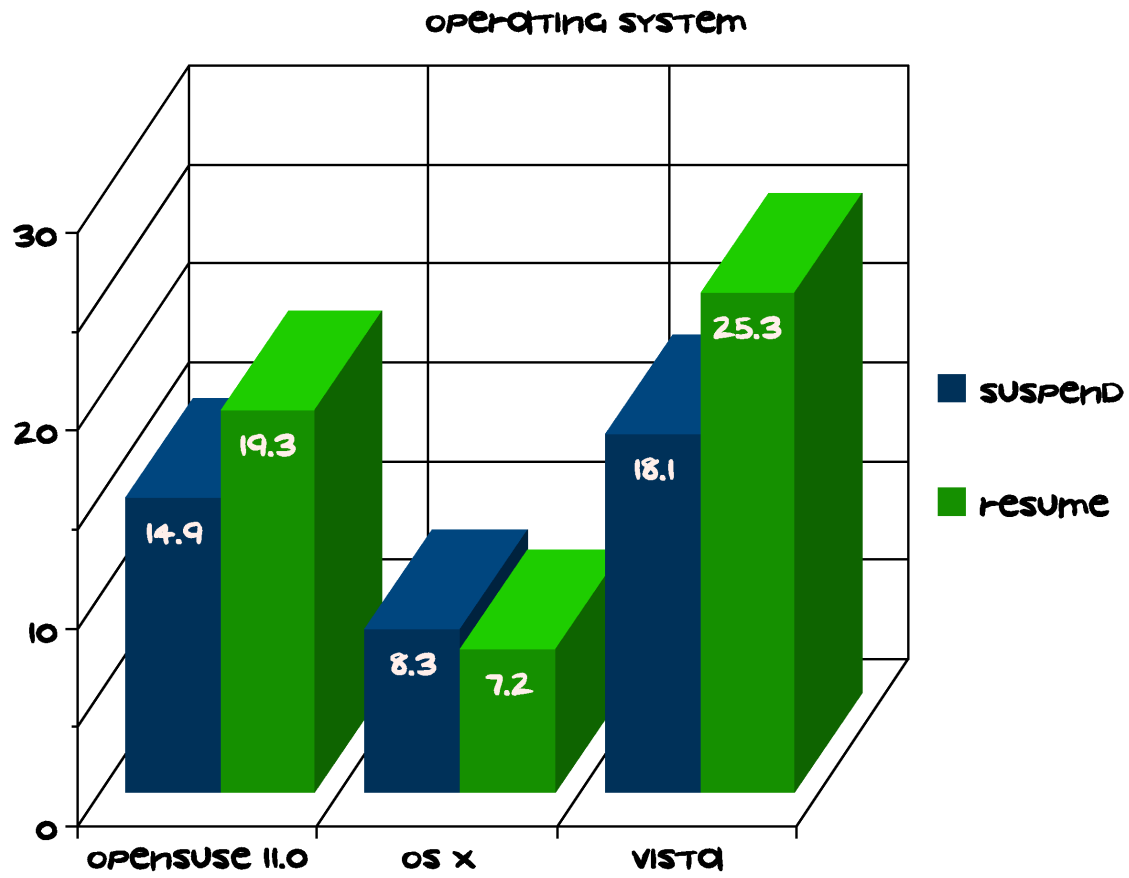

Suspend to Disk (Applications Running) – Plain Numbers

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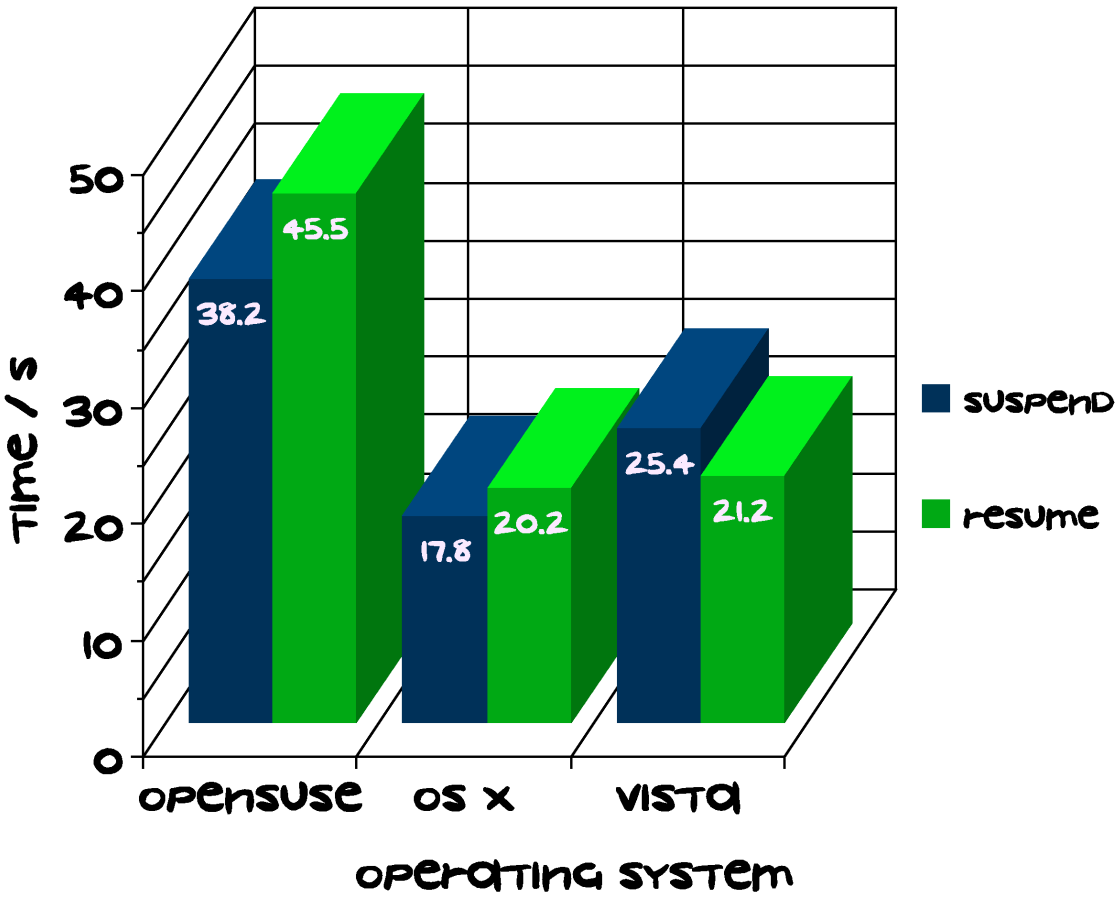

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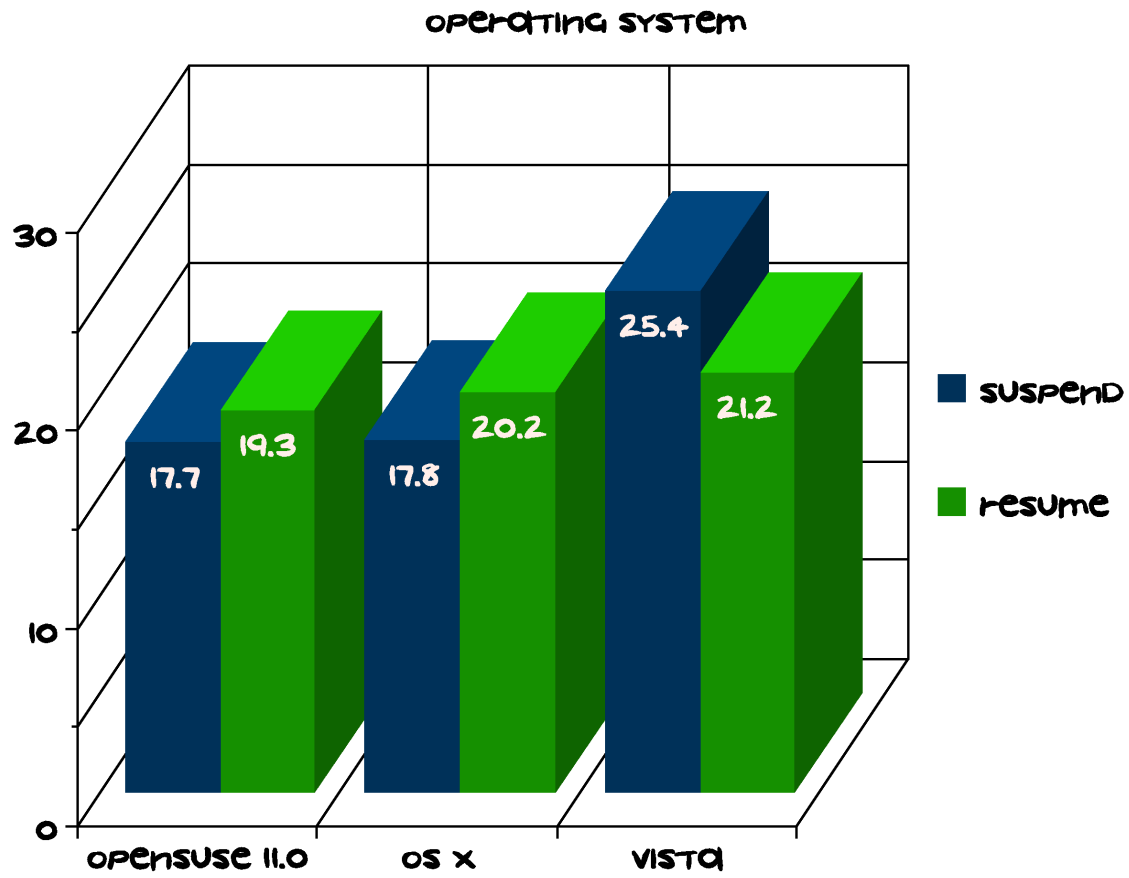

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Suspend to Disk (Applications Running) – Commented

- Last year: Mac OS X suspends and resumes only a little bit faster than Vista, openSUSE needs about two times longer
- This year: openSUSE takes the crown!

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Supported platforms

- UPEK/SGS Thomson Microelectronics fingerprint reader (USB ID 0483:2016)
- Supported laptops
  - ASUS
  - Dell
  - IBM/Lenovo
  - Toshiba

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openSUSE Integration

- openSUSE 11 ships with full support for GNOME (GDM, gnome-screensaver)
- KDE3/KDE4 support is almost ready, will need some online update or build service update

Laptop Database

- Internal laptop database containing information about ACPI support, PCI information, etc.
- With openSUSE 10.3: Extended with test data regarding the Energy Star specification

Energy Star Compliance

Software and Hardware Involvement

- Systems must meet a certain software configuration
- Power Consumption must not need exceed certain limits

Operational Mode: *Idle*

- System AC Powered
- Display is off
- Idle limit for laptops with powerful graphic cards: 22.0*Watt*
- Idle limit for all other laptops: 14.0*Watt*

Power Consumption Comparison: Lenovo ThinkPad T61

openSUSE 10.3

- Idle power consumption: $14.35W$
- $0.35W$ above the Energy Star limit

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- Below $14.0W$ and thus below the Energy Star limit

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How comes?

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Known Techniques

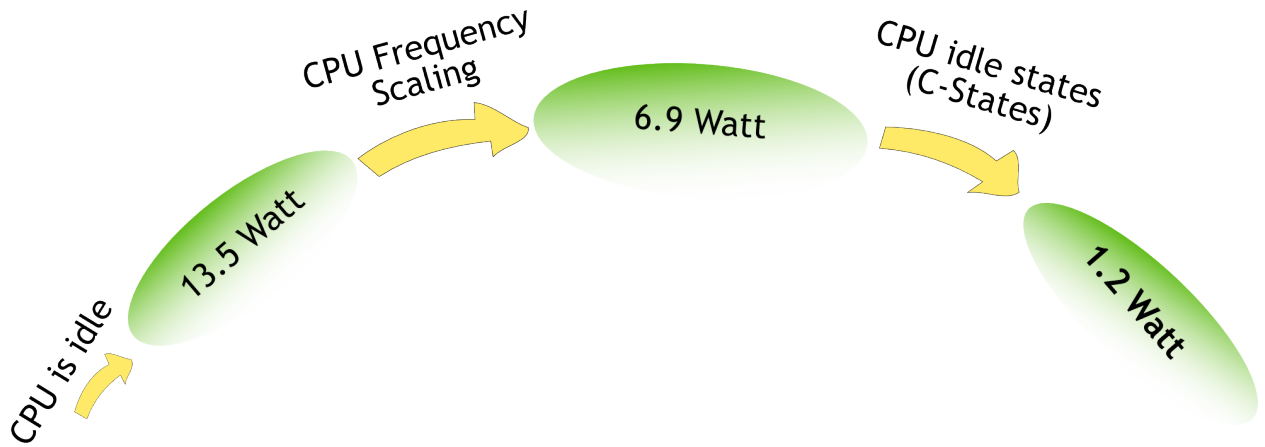
CPU Frequency Scaling (ACPI P-States)

- Reduce CPU frequency when not needed
- Intel SpeedStep, AMD PowerNow, etc.

CPU idle states (ACPI C-States)

- Set CPU to low power mode if no instructions are executed

Intel Core 2 Duo T7700 Power Consumption



Conclusion

- Huge potential in deepest sleep mode
- Common goal: Be idle as long as possible!
- Policy also knows as *race to idle*

Bad Boys

Processes are waking up the CPU

- Desktop applications
- System daemons
- Kernel threads

Solution: Fix applications and kernel

- Applications must not unnecessarily wake up the CPU
- Ongoing process over the last couple of month (cf. PowerTop)
- It seems to pay off!

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Running Battery powered...

- Not polluting the environment when on AC is good, but...
- ...isn't there something we can do for typical laptop use cases?
- Users do accept a certain amount of performance loss in favour of longer battery runtimes

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Wireless

Basic approach of IEEE 802.11 specification

- Most power is spent when packages are submitted
- Consequence: Short bursts of submission, afterwards clients goes to sleep
- cf. *race to idle*

Clients: Two modes

- Active: Radio always on
- Sleep mode: Intermittently turning off the radio
  - Periodic wake-ups to check if packages are available

Supported Drivers

- IWL3945 and IWL4945

Example: Intel PRO/Wireless 3945ABG, no traffic

- Full power: $\approx 1.15W$
- Sleep mode, but fully functional: $\approx 0.3W$

```
$ echo 6 > \
/sys/bus/pci/drivers/iwl*/000*/power_level
```

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SATA: Aggressive Link Power Management

- SATA link to the disk is put into low power mode when no IO
- Automatically woken up when requests arrive

Example: Fujitsu hard disk with 80 GB (SATA)

- Full power: $\approx 2.5W$
- ALPM enabled: $\approx 1.8W$

```
$ echo {min/medium}_power > \
/sys/class/scsi_host/$HOST/link_power_management_policy
```

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Shutdown when Idle

- Disable sound cards after time out period
- Short wakeup delay
- Power savings: $\approx 0.5 Watt$

```
$ echo 10 > \
/sys/module/snd_hda_intel/parameters/power_save
```

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Possible Power Savings

Component	Power Saving
Hard disk	$\approx 0.7W$
Wireless	$\approx 0.8W$
Sound card	$\approx 0.5W$
	$\approx 2.0W$
CPU	Unsafe coefficient
	$2.0W + CPU$

Power Consumption Comparison: Lenovo ThinkPad T61

Prerequisites

- Battery powered
- Display off

openSUSE 10.3

- Idle power consumption: 11.11W

Power Consumption Comparison: Lenovo ThinkPad T61

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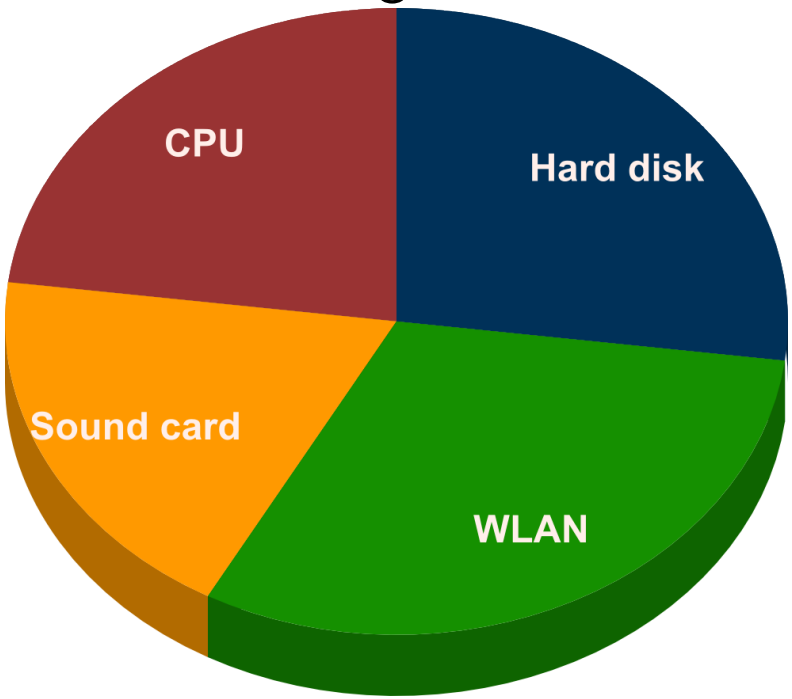
- Idle power consumption: $11.11W$

openSUSE 11.0

- Idle power consumption: $8.51W$
- Makes up $\approx 23\%$
- Power savings: $11.11W - 8.51W = 2.6W$

Power saving distribution



Power Savings

Component	Power Saving
Hard disk	$\approx 0.7W$
Wireless	$\approx 0.8W$
Sound card	$\approx 0.5W$
CPU	$\approx 0.6W$
	$\approx 2.6W$

Dock Stations and Bays

Ongoing development efforts

- Lot of work supporting dock stations and bay devices in a generic way
- Always considered as: "Does not work anyway"

With 11.0...

Everything which does not work is considered a bug. So file it!

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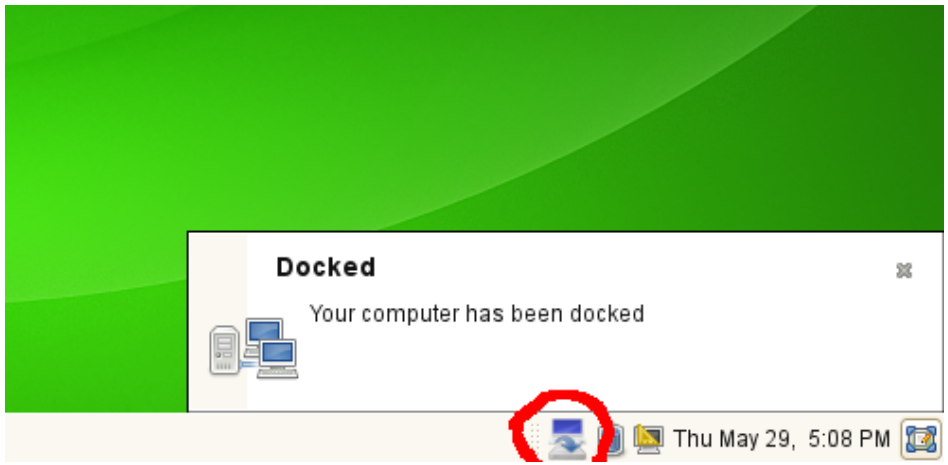
GNOME Docker

- Dock station applet caring about:
  - User notifications
  - Hotkeys (e.g. FN-F9)
  - External displays connected to the dock (xrandr)
- GNOME Docker *will* care about:
  - Safely removing devices in the dock



6 Wireless

- The New Wireless Stack mac80211
- Overview of Wireless Drivers
- Which Card Works Reliable?
- What Next?

7 NetworkManager

- Features

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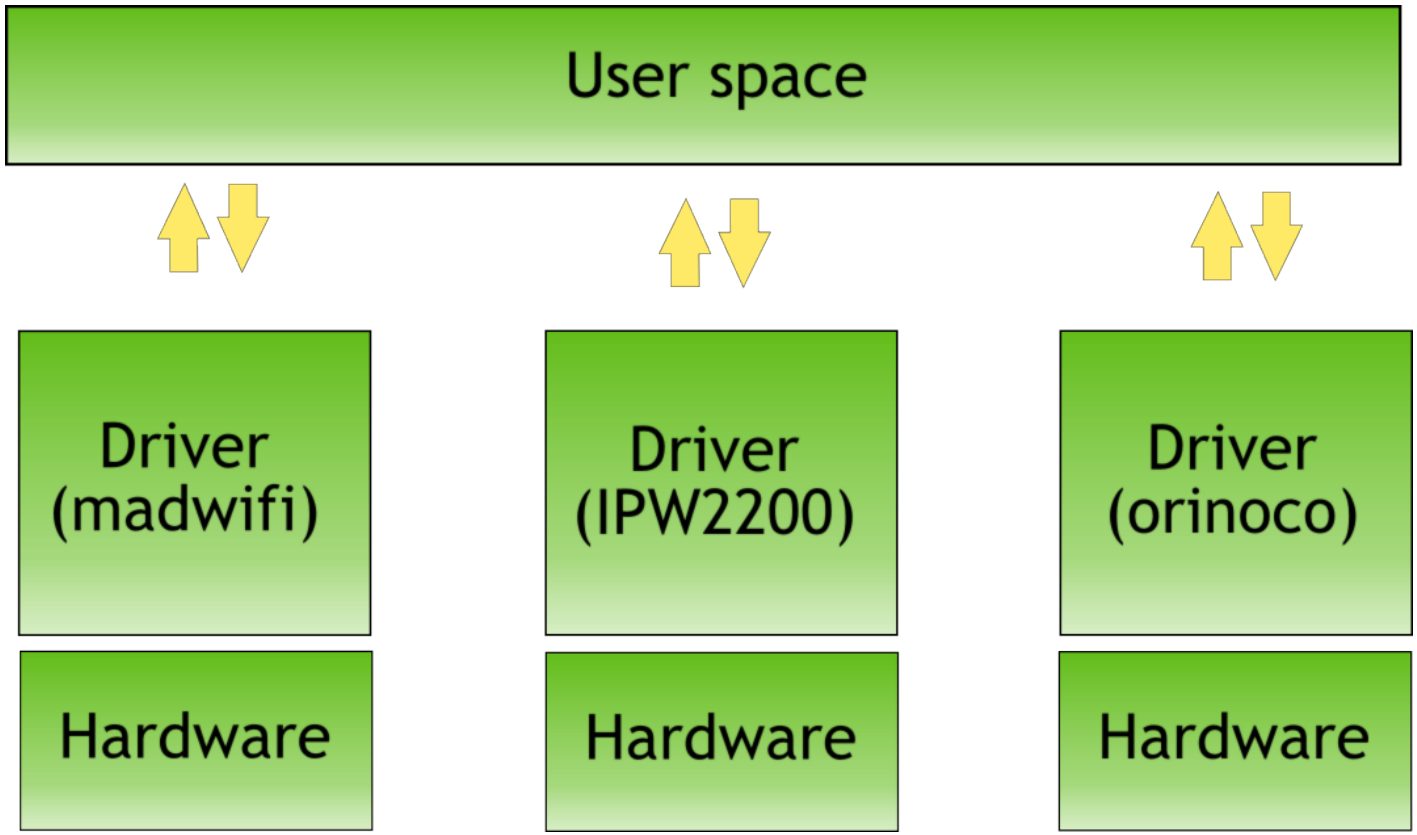
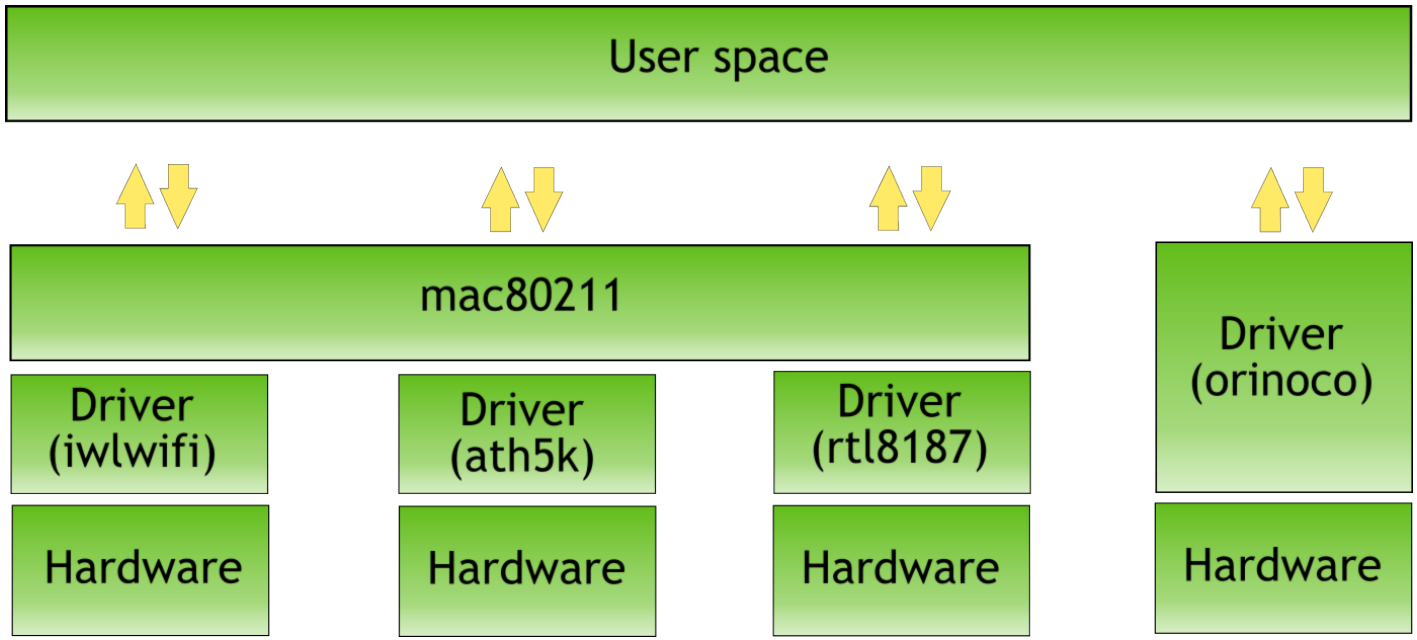
From d80211 to mac80211

- Devicescape released the d80211 stack in 2006 to the open source community
- The stack was cleaned up and renamed to mac80211 for inclusion in the Linux kernel 2.6.22
- Implements functions of the 802.11 specification needed by nearly all wireless drivers

Former Architecture



Architecture with mac80211



Advantages

- No need to reinvent the wheel for every device driver again
  $\Rightarrow$ wireless driver development is much less work
- New device drivers obtain all implemented features at once
  $\Rightarrow$ WPA support
  $\Rightarrow$ AP mode support
- All mac80211 based device drivers behave the same
  $\Rightarrow$ user space does not need driver specific quirks anymore
- Better test coverage due to being used by more then one driver

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Overview of mac80211 Based Device Drivers

Driver	*Supported Devices*
ath5k	Atheros chipsets, replaces madwifi
rt2x00	RaLink chipsets
iwlwifi	Intel PRO/Wireless 3945 and 4965, replaces ipw3945
b43	Broadcom PCI chipsets, replacement for bcm43xx
rndis_wlan	Broadcom USB chipsets
rtl818x	Realtek USB chipsets
...	

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Which Card Works Reliable?

Built-in PCI Devices

- Intel PRO/Wireless 3945/4965

PCMCIA Cards

- Atheros

USB Sticks

- Zydas ZD1211
- RaLink rt2570

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What Next?

Future of mac80211

- Wireless drivers and stack are still under heavy development
  $\Rightarrow$ Support for even more devices is on its way
- Features currently worked on:
  $\Rightarrow$ Mesh networking (802.11s)

Additional information: `http://wireless.kernel.org`

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New Features

- Multiple active connections (e.g. wireless and wired connection)
- Support for UMTS and GSM connections
- Static IP configuration
- Support for a broader range of wireless setups

Thanks for coming!